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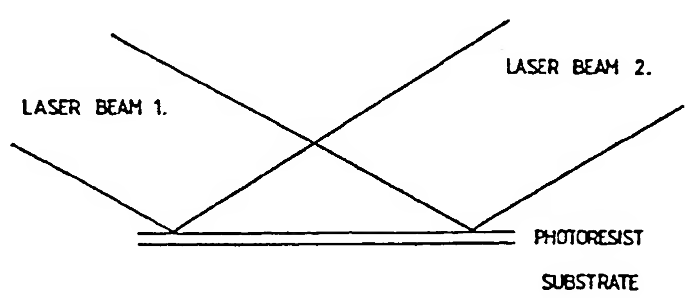
(54) Improvements relating to photolithography.

(57) In a method of photolithography in which optical radiation is directed onto a layer of photoresist coated on a substrate, the tendency towards generation of spurious image features is much reduced by selecting the substrate and the optical radiation used in the exposure step so that the substrate is absorptive of said optical radiation. The use of, for example, a coloured glass substrate together with optical radiation of appropriate wavelength is found to be highly beneficial in maintaining accuracy of the resultant image.

Fig.1.



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"IMPROVEMENTS RELATING TO PHOTOLITHOGRAPHY"

Photolithographic techniques are used in a variety of processes in order to generate an image carried by a substrate. A photoresist is frequently used as part of a photolithographic process. Typically, the photoresist is coated onto a substrate by spinning, dipping, spraying or any other suitable technique. The photoresist layer is then exposed to optical radiation and developed.

A problem frequently encountered in photolithographic processes is the generation of spurious image features. These degrade the resultant image and can be particularly deleterious in, for example, mass production processes.

In standard practice, the photoresist is coated onto a transparent substrate such as polished glass. We believe that the rear surface of the substrate, and defects or contamination on it, are primarily responsible for scattering light which results in spurious image features being generated. A secondary cause of spurious image features is imperfections in the body of the substrate itself. Anti-reflection coatings are known and used in a variety of photographic or optical processes. Such coatings, however, do not prevent the light reaching the rear surface of the substrate and hence may not completely prevent reflections from the rear surface. Also anti-reflection coatings have no effect at all on the generation of spurious image features arising from imperfections within the body of the substrate. Such spurious image features can severely degrade the article produced after the photoresist is exposed and developed. This degradation can be very serious when, for example, the end product is a diffraction grating (e.g. in the manufacture of disks for optical data storage) or a so-called Compact Audio Disk.

We have found that the generation of spurious image features can be reduced or eliminated if a substrate is used which is absorbing to the optical

radiation used in the exposure of the photoresist. More particularly, the present invention provides a method of photolithography in which optical radiation is directed onto the surface of a thin layer of a photoresist coated on a substrate in order to generate, after development, an image carried by the substrate, characterised in that the substrate and the optical radiation used are selected so that the substrate is capable of absorbing said optical radiation.

Preferably, the substrate is strongly absorbing to the optical radiation used in the exposure step. Advantageously the substrate should have an optical density of 2.0 or greater when measured at the wavelength, or over the band of wavelengths, which is to constitute the optical radiation. Best results are generally achieved when the optical density of the substrate exceeds 4.0.

The absorbing glass can be any which prevents the recording light from passing through it. For example when an argon ion laser emitting radiation at 458 nm is used a filter glass marketed as OG550 from Schott and having an optical density of greater than 5 at 458 nm is suitable.

The use of an absorbing substrate (e.g. one of coloured glass) rather than one which is transmissive to the radiation used in the exposure step tends to prevent the radiation reaching the rear surface of the substrate.

The invention is expected to find application in a number of techniques. For example, it may be used in the manufacture of holographic diffraction gratings. A second example is in mastering of Compact Audio Disks or similar read-only information storage disks. In these a glass disk is coated with a photoresist. The disk is then rotated beneath a focussed beam of optical radiation which could be from a laser. By modulating the optical radiation a series of pits will be formed when the photoresist is developed. In general spurious pits could

be formed by scattered light. However, the present invention avoids this problem by absorbing any light which passes through the photoresist thereby preventing any backscatter.

The invention will be illustrated by the following Example.

EXAMPLE

This Example illustrates the way this invention can be used to improve the performance of a holographic diffraction grating. This type of diffraction grating offers advantages over ruled diffraction gratings by having reduced scatter. However, residual scatter can still result from surface imperfections. These can arise by light scattered from the bulk of the substrate or from the rear surface of the substrate during the recording process, which is as follows:

A glass plate in the form of filter glass OG550 manufactured by Schott, and having an optical density of greater than 5.0 to light at a wavelength of 458 nm, was coated with a photoresist by applying the photoresist to the plate and spinning the plate about an axis normal to its plane at 1,000 r.p.m. Several photoresists may be used; the one in this Example was AZ1450J from Shipley Chemicals. The plate was then exposed to two crossed laser beams as shown in Figure 1. The laser beams were from an Argon ion laser at a wavelength of 458 nm. Following an exposure density of about 100 mJ/sq cm the resist was etched in Shipley Microposit developer. This resulted in the exposed regions of the resist being removed from the surface to give a result as shown in Figure 2. The surface of the photoresist had a regular texture or pattern which in section was sinusoidal. The ideal profile is usually degraded by virtue of light being scattered from imperfections in the glass and from the rear surface, and hence departs noticeably from the regular sinusoidal profile of Figure 2. By virtue of the present invention the effects of scattered light were

eliminated since all light passing through the resist layer was absorbed in the substrate. This effect is demonstrated in Figure 3 where it can be seen that the grating recorded on absorbing glass (Figure 3a) is much more pure in form than that shown in Figure 3b, which was prepared in precisely the same way as that of Figure 3a except for the use of a conventional non-absorbing glass plate as substrate.

Claims:

1. A method of photolithography in which optical radiation is directed onto the surface of a thin layer of a photoresist coated on a substrate in order to generate, after development, an image carried by the substrate, characterised in that the substrate and the optical radiation used are selected so that the substrate is capable of absorbing said optical radiation.

2. A method according to claim 1, characterised in that the substrate used is a coloured glass.

3. A method according to claim 1 or 2, characterised in that the substrate has an optical density of at least 2.0 when measured at the wavelength, or band of wavelengths, of said optical radiation.

4. A method according to claim 3, characterised in that the substrate has an optical density of at least 4.0.

5. A method according to claim 1, 2, 3 or 4, characterised in that the substrate is an optical filter glass.

6. A method according to claim 5, characterised in that the filter glass is Schott OG550 and the optical radiation is at a wavelength of 458 nm.

7. A method of generating a holographic diffraction grating in which a photoresist is coated onto a substrate and is exposed to two crossed laser beams to generate a diffraction pattern at the photoresist surface, characterised in that the substrate is strongly absorbent to light of the wavelength of said laser beams.

Fig.1.

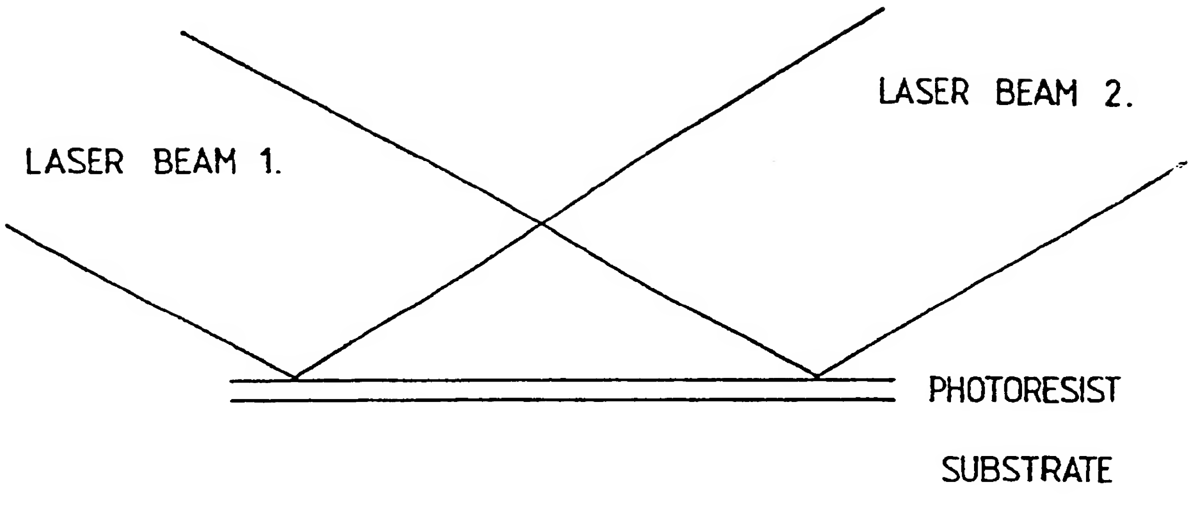

LASER BEAM 1.
LASER BEAM 2.
PHOTORESIST
SUBSTRATE

Fig.2.

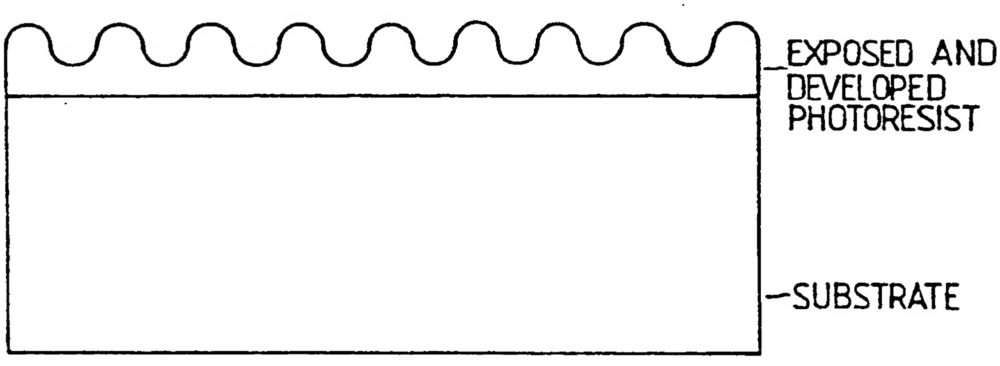
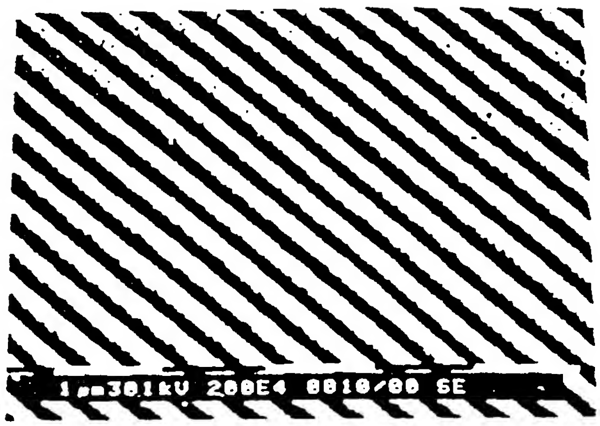
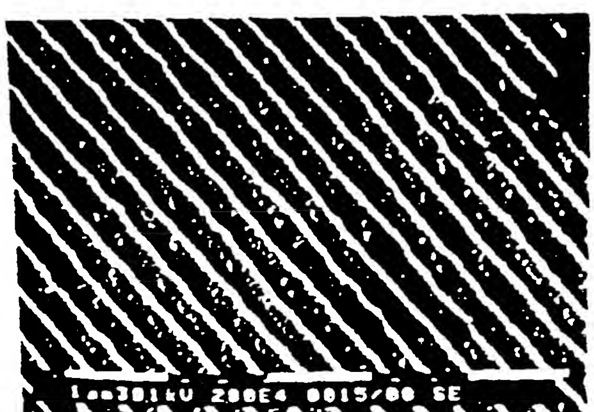

EXPOSED AND DEVELOPED PHOTORESIST
SUBSTRATE

Fig.3A.



RECORDING USING COLOURED GLASS SUBSTRATE.

Fig.3B.



RECORDING USING CLEAR GLASS SUBSTRATE.

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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 85 30 418-

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
X	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 20, no. 9, February 1978, page 3393, New York US; J.J. FRANKENTHALER et al.: "Additively plating on both sides of transparent laminates" * Whole document *	1-4	G 03 F 7/25 G 03 F 7/20 G 03 F 7/02 G 11 B 7/26 G 03 H 1/02 G 02 B 5/18 G 03 C 1/84
A	EP-A-0 043 993 (HUGHES AIRCRAFT) * Claims 1,2; figure *	7	
A	US-A-4 402 571 (J.J. COWAN et al.) * Claims; figure 1 *	7	
A	US-A-2 391 127 (E.K. CARVER) * Page 3, lines 5-18; figure 7; claims *	1	TECHNICAL FIELDS SEARCHED (Int. Cl 4)
A	PATENTS ABSTRACTS OF JAPAN, vol. 6, no. 8 (P-98) [886], 19th January 1982; & JP - A - 56 134 329 (TOKYO SHIBAURA DENKI K.K.) 21-10-1981	1	G 03 C 1 G 03 C 5 G 03 F 7 G 11 B 7 G 03 H 1 G 02 B 5 G 03 F 1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-09-1985	PHILOSOPH L.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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